

## UNCLASSIFIED

<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)</b>								DATE <b>February 1999</b>		
BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601104A University and Industry Research Centers</b>						
COST (In Thousands)	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
Total Program Element (PE) Cost	43733	44839	47066	48024	49268	49858	51969	54689	Continuing	Continuing
BH50 Telecommunications Research	9656	9073	9668	9821	9978	10459	10947	11483	Continuing	Continuing
BH53 Advanced Distributed Interactive Simulation Research	554	1923	1186	1202	1222	2393	2567	2691	Continuing	Continuing
BH54 Advanced Sensors Research	9871	9257	9865	10022	10182	10672	11249	11817	Continuing	Continuing
BH56 Advanced Displays Research	4351	4416	5896	5992	6087	6251	6635	6996	Continuing	Continuing
BH59 University Centers of Excellence	3964	4247	6262	6568	7147	5284	5581	5914	Continuing	Continuing
BH62 Electromechanics and Hypervelocity Physics	9041	8669	6905	7006	7128	6404	5701	6102	Continuing	Continuing
BH64 Materials Center of Excellence	1736	2221	2434	2472	2511	2560	2761	2925	Continuing	Continuing
BH65 Microelectronics Center of Excellence	1853	2314	1973	2005	2037	2667	2858	3021	Continuing	Continuing
BH73 National Automotive Center of Excellence	2707	2719	2877	2936	2976	3168	3670	3740	Continuing	Continuing

**A. Mission Description and Budget Item Justification:** The Army's initiative to create three open, federated laboratories is an innovative and forward thinking approach focusing the talents of industry and academia on critical technology needs of the Army. The federated laboratory is a partnership between the Army Research Laboratory (ARL) and the private sector involving cooperative agreements, integrated management and staff rotation, education and communication. The basic construct of a federated laboratory is to continue strong in-house involvement to meet Army-unique requirements where there is little external expertise in the technologies, and to forge direct associations with industry/university consortia with recognized competencies in specific technology areas where the centers of expertise are definitely outside of the Government (i.e. telecommunications). Under the federated laboratory approach, ARL formed partnerships with consortia consisting of at least one each of an industrial company, a major university, and a Historically Black College or University/Minority Institution (HBCU/MI). Long-term cooperative agreements (5 years) were established in three key areas with consortia that have become "virtual labs" within ARL and function as any other ARL division. Research is jointly planned and executed and Army scientists and engineers are intermingled with consortia researchers through long term rotational assignments. The federated laboratory approach for ARL is in accordance

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Exhibit R-2 (PE 0601104A)

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DATE  
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## BUDGET ACTIVITY

**1 - Basic Research**

## PE NUMBER AND TITLE

**0601104A University and Industry Research  
Centers**

with the 1991 Base Realignment and Closure, and the Department of Defense mandate to exploit private sector research and reduce infrastructure. This program element also

includes the Army's Centers of Excellence, which are the centerpiece of academic linkage to Army R&D organizations. Centers of Excellence continue to be an integral part of the Army's research investment strategy, along with single investigator programs and Army laboratory research. Centers have proven to be highly effective in many applications-oriented projects, in areas such as rotary wing technology and electronics. Centers couple state-of-the-art research programs with broad-based graduate education programs to increase the supply of scientists and engineers in areas of Army importance. Work in this program element is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and DoD Project Reliance.

<b>B. Program Change Summary</b>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>
Previous President's Budget (FY 1999 PB)	45138	48459	50799	51769
Appropriated Value	46576	45138		
Adjustments to Appropriated Value				
a. Congressional General Reductions	-1438	-299		
b. SBIR / STTR	-1065			
c. Omnibus or Other Above Threshold Reductions	-340			
d. Below Threshold Reprogramming				
e. Rescissions				
Adjustments to Budget Years Since <u>FY 1999</u> PB			-3733	-3745
Current Budget Submit (FY 2000 / 2001 PB)	43733	44839	47066	48024

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BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601104A University and Industry Research Centers</b>				PROJECT <b>BH50</b>		
COST (In Thousands)	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
BH50 Telecommunications Research	9656	9073	9668	9821	9978	10459	10947	11483	Continuing	Continuing

**Mission Description and Justification:** This project establishes long term collaboration between the Army Research Laboratory and competitively selected industry/university consortium headed by Lockheed Sanders, Nashua, NH, for the purpose of leveraging world class research relevant to Army needs. Battlefield telecommunications involve the reliable, timely, and secure electronic transport of multi-media information over heterogeneous, digital networks exhibiting dynamic topologies. The technical areas addressed under this project are: wireless battlefield digital communications; tactical/strategic interoperability; information distribution; multi-media concepts.

**FY 1998 Accomplishments:**

- 9656 -Developed and demonstrated protocols that support seamless connectivity between satellite and terrestrial segments to optimize communication links between various levels of command.
- Evaluated the applicability of ATM technology to multi-rate battlefield wireless environments.
- Developed formal testing and validation methodologies for network simulation models for Army battle commands systems.
- Developed and demonstrated an executable-code encoded hybrid network simulation to validate commercial specifications in Army communication systems.
- Developed and demonstrated techniques to support push-pull flow control among information servers based on real-time network events to improve information transfer on the battlefield.
- Developed and demonstrated scalable multimedia compression techniques which track the rate-distortion curve as the rate is reduced by traffic or bandwidth to enhance wireless battlefield communication.

Total 9656

**FY 1999 Planned Program:**

- 8832 -Develop and demonstrate alternative signaling protocols for call hand-off, origination, delivery, and internet protocol mobility in a highly mobile battlefield environment.
- Develop a network management system based on a next-generation, software-based, fault-tolerant distributed object computing platform and a multi-tier network architecture to manage tactical communication networks.
- Demonstrate tactical data exchange across multiple platforms using adaptive flow control and routing, meta data queries, and user-controllable threshold criteria to enhance seamless information transfer on the battlefield.
- Demonstrate packetization and error recovery methods for multimedia communications over wireless battlefield channels.

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PROJECT <b>BH50</b>		
<p><b>FY 1999 Planned Program: (continued)</b></p> <ul style="list-style-type: none"> <li>-Demonstrate inter-media and inter-participant multimedia synchronization using sub-millisecond time synchronization to provide multimedia applications to the tactical network.</li> <li>• 241 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs</li> </ul> <p>Total 9073</p> <p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 9668 - Develop data distribution schemes based on adaptive triggers and intelligent agents to support a fault tolerate architecture.</li> <li>- Develop a network management system based on a next-generation, software-based, fault-tolerant distributed object computing platform and a multi-tier network architecture to manage tactical communication networks.</li> <li>-Demonstrate compression techniques for multimedia delivery to tactical networks.</li> <li>-Simulate large-scale highly mobile untethered battlefield networks.</li> <li>-Investigate laser communications using adaptive optical techniques.</li> </ul> <p>Total 9668</p> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 9821 - Develop information hiding techniques to enhance information assurance over wireless battlefield channels.</li> <li>- Simulate large-scale highly mobile untethered battlefield networks.</li> <li>- Demonstrate 3D-network management system integrated into advanced visualization techniques for tactical command and control.</li> <li>- Demonstrate communications using a laser system with adaptive optics.</li> <li>- Investigate mobile wireless communications at frequencies above 5 gigabytes.</li> <li>- Investigate global information distribution over satellites or surrogate satellites with intelligent, adaptive multicast techniques.</li> </ul> <p>Total 9821</p>		
<p>Project BH50</p> <p align="center"><i>Page 4 of 20 Pages</i></p> <p align="right">Exhibit R-2A (PE 0601104A)</p>		

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BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601104A University and Industry Research Centers</b>				PROJECT <b>BH53</b>		
COST (In Thousands)	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
BH53 Advanced Distributed Interactive Simulation Research	554	1923	1186	1202	1222	2393	2567	2691	Continuing	Continuing

**Mission Description and Justification:** This project establishes long term collaboration between the Army Research Laboratory and a competitively selected Army Center of Excellence in Information Sciences (ACEIS). The Clark Atlanta University, a HBCU, will perform research in information science. The research focuses on the mid to far-term needs of Army After Next (AAN) Command and Control Systems. It performs research in information science with emphasis in the following areas: interactive and intelligent systems; database and information systems; and distributed and parallel processing systems. Work in this project was previously accomplished in PE 0601102A/BH57. The project also supports the Army High Performance Computer Research Center beginning in FY99. This effort is restructured from project AH48, PE 0601102A.

**FY 1998 Accomplishments:**

- 554 - Developed a virtual environment testbed to perform research into human computer interaction (3D instead of 2D) in battlefield situations.
- Applied intelligent data base capabilities to provide advanced solutions to Army logistics problems.
- Applied parallel processing techniques to tactical command and control.

Total 554

**FY 1999 Planned Program:**

- 577 - Explore the visual clues that detect a "Sense of Presence" on a virtual battlefield that include the detection, identification, and location of visual stimuli, conveyed to the human via parallel paths.
- Develop techniques to optimize each stimulus in order to develop effective visualization applications.
- Explore how battle command knowledge and experience can be utilized to provide visual problem solving for a knowledge base using the internet.
- Provide an experimental environment to formulate advanced concepts for information transfer systems.
- Develop a means for identifying signatures of anomalous activities in large data systems.
- Explore issues associated with transfer of learning in virtual environments.
- 1295 - Extend techniques for simulation of parachute inflation fluid-structure interactions and apply them to parachute fluid structure interactions for full 3D parachute models.
- Develop methods to model the effect of the vortex-wake system behind a large transport aircraft on paratrooper separation from aircraft.
- Develop methods to model aircraft wake vortices and vortice shedding as it relates noise generation and suppression from helicopter blades.

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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>		DATE <b>February 1999</b>
BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601104A University and Industry Research Centers</b>	PROJECT <b>BH53</b>
<p>- Develop adaptive girding, mesh moving, and multi-body modeling techniques and apply these techniques to modeling paratrooper exit from large transport aircraft.</p> <p><b>FY 1999 Planned Program: (continued)</b></p> <p>- Develop mesh-free methods for large deformation analysis of solids and structures; capability to model crack and shear band growth is essential to first principles modeling of the physics of weapons effects.</p> <p>- Develop, as required for new research applications, fast and efficient parallel mesh generation/regeneration algorithms for use in fluid-object (mesh moving) applications or solution adaptive computations.</p> <p>- Develop highly parallel solvers for sparse linear systems for applications to solve problems in fluid flow, structural mechanics, electromagnetics and heat transfer.</p> <p>- Extend virtual environment using neural nets and fuzzy logic. Incorporate advanced data mining techniques into intelligent data base capabilities.</p> <p>- Investigate technologies for information distribution in a wireless mobile environment.</p> <p>• 51 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs</p> <p>Total 1923</p> <p><b>FY 2000 Planned Program:</b></p> <p>• 732 - Develop parameters to optimize the "Sense of Presence" and performance in battlefield virtual environments.</p> <p>- Explore knowledge acquisition, knowledge dissemination, concept analysis, and decision tools to enable users to engage in visual problem solving technologies when working with large knowledge bases.</p> <p>- Identify signatures of anomalous activities in large data systems using cluster analysis, Fourier Transforms, and Neural Networks.</p> <p>- Study the effects of training transfer from a virtual to a real world environment. .</p> <p>• 454 - Extend techniques for simulation of parachute inflation fluid-structure interactions and apply them to parachute fluid structure interactions for full 3D parachute models. In conjunction with Natick, verify model against empirical data.</p> <p>- Develop methods to model the effect of the vortex-wake systems behind multiple large transport aircraft flying in formation on paratrooper deployment (i.e., extend model to multiple aircraft and multiple paratroopers).</p> <p>Total 1186</p> <p><b>FY 2001 Planned Program:</b></p> <p>• 758 - Evaluate prototype "Sense of Presence" in a battlefield virtual environment.</p> <p>- Explore techniques to prototype identification of signatures to automatically handle the data analysis in real time on an active system.</p> <p>- Prototype knowledge bank to test concept in virtual problem solving.</p>		
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BUDGET ACTIVITY <b>1 - Basic Research</b>		PE NUMBER AND TITLE <b>0601104A University and Industry Research Centers</b>
•	444	- Deliver production quality software which can be used by Army personnel to the Natick RDEC for simulation of parachute inflation fluid-structure interactions and apply parachute fluid structure interactions for full 3D parachute models. - In conjunction with Natick and other DoD researchers, verify computational models for simulating the vortex-wake systems behind multiple large transport aircraft flying in formation on paratrooper deployment .
Total	1202	

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BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601104A University and Industry Research Centers</b>				PROJECT <b>BH54</b>		
COST (In Thousands)	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
BH54 Advanced Sensors Research	9871	9257	9865	10022	10182	10672	11249	11817	Continuing	Continuing
<p><b><u>Mission Description and Justification:</u></b> This project establishes long term collaboration between the Army Research Laboratory and a competitively selected industry/university consortium for the purpose of leveraging world class research relevant to Army needs. Advanced sensors are the elements of systems that view the environment and convert the basic raw sensor data into meaningful information suitable for transmission over tactical networks. The technical areas addressed under this project are: multidomain smart sensors, to include multispectral infrared focal plane arrays; multisensor fusion automatic target recognition algorithms, to include synthesis of sensor modeling; radar sensors, to include atmospheric and terrain effects on propagation; and signal processing, capitalizing on commercially available hardware, microsensors which integrate microelectromechanical systems (MEMS), acoustic seismic, and RF technologies.</p> <p><b>FY 1998 Accomplishments:</b></p> <ul style="list-style-type: none"> <li>• 2059 Completed first iteration design/fabrication cycle for the power amplifier/low noise (PALNA) monolithic microwave integrated circuit (MMIC), a key component for future low-cost Electronically-Scanned Arrays. Power densities of 250mW/mm were achieved and transmit/receive (T/R) switching was demonstrated, lending confidence in second pass run next year.</li> <li>• 2329 Conducted feasibility demonstration of Multi-Domain Smart Sensors (MDSS); obtained pixel registered long wavelength infrared (LWIR) and medium wavelength infrared (MWIR) imagery with boresighted cameras.</li> <li>• 2046 Demonstrated use of configurable processing for image fusion of two-color LWIR/MWIR imagery and evaluated mapping of multi-scale UWB SAR image formation algorithm to a configurable processor.</li> <li>• 1230 Developed joint video/inertial testbed and successfully demonstrated joint video/inertial kinematic state estimation.</li> <li>• 2207 Developed laser radar (ladar) automatic target recognition (ATR) algorithm for use in Target Acquisition ATD.</li> </ul> <p>Total 9871</p> <p><b>FY 1999 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 1804 Develop a comprehensive millimeter wave (MMW) radar backscatter database for low grazing angle backscatter and a scattering model for improved target tracking and detection algorithms.</li> <li>• 2170 Demonstrate the application of low-power signal processing techniques to a medical monitoring problem and evaluate a network situation of distributed signal processing.</li> <li>• 1524 Demonstrate imaging with dual color 256x256 quantum well infrared photodetector (QWIP) and 240x320 HgCdTe (MCT) IR Focal Plane Arrays (IRFPAs); obtain 35% quantum efficiency for QWIP detector array.</li> <li>• 1431 Evaluate distributed microsensor testbed in a MOUT environment.</li> </ul>										
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BUDGET ACTIVITY <b>1 - Basic Research</b>		PE NUMBER AND TITLE <b>0601104A University and Industry Research Centers</b>
PROJECT <b>BH54</b>		
<p><b>FY 1999 Planned Program: (continued)</b></p> <ul style="list-style-type: none"> <li>• 2083 Demonstrate improvement in forward looking infrared (FLIR) ATR performance with update from recent reconnaissance imagery; demonstrate fusion of two sensors for detection of mines and unexploded ordinance.</li> <li>• 245 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs</li> </ul> <p>Total 9257</p> <p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 2000 Demonstrate a 94GHz radar with a 64-element electronically scanned antenna at an Aberdeen test site. The antenna will capable of receiving a transmitting in two orthogonal polarizations and will employ high level of integration necessary for low cost production.</li> <li>• 2412 Demonstrate MDSS with dual color IRFPAs and eye safe ladar; demonstrate spatial noise mitigation and low power optical IRFPA read-out techniques.</li> <li>• 2102 Evaluate computing architectures for the application of adaptive computing techniques to low-power signal processing for networks of distributed microsenors.</li> <li>• 1178 Evaluate combination of fixed and mobile unattended ground sensors.</li> <li>• 2173 Multi-fusion algorithms in support of third generation imaging sensors.</li> </ul> <p>Total 9865</p> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 10022 Research innovative adaptive signal processing techniques to enable fusion of self-organizing networks of multidomain. Research adaptive multisensor fusion algorithm that requires minimal training for detection and recognition of battlefield targets. Explore innovative hardware/software architecture for on-sensor processing of advanced multi and hyperspectral sensors, and multimode RF sensors.</li> </ul> <p>Total 10022</p>		
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BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601104A University and Industry Research Centers</b>						PROJECT <b>BH56</b>

  

COST (In Thousands)	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
BH56 Advanced Displays Research	4351	4416	5896	5992	6087	6251	6635	6996	Continuing	Continuing

  

**Mission Description and Justification:** This project establishes a competitively selected university/industry consortium headed by Rockwell International Corporation, Cedar Rapids, IA, to provide solutions for the many requirements for information assimilation on the battlefield. Displays and control constructs are the interface between human users and computers. This consortium will develop display subsystem architecture which can provide access to all information of practical use, provide data visualization in an efficient manner and use the advanced hardware and software technologies to address the human sensory modality without overloading the user and degrading performance. Work in this project differs from the Defense Advanced Research Projects Agency's (DARPA's) program, which aims to establish a domestic capability for display hardware. The technical areas being addressed under this project are: human-computer interface in an information rich environment; display configuration, real time visualization, architecture, information presentation, and control coupling.

**FY 1998 Accomplishments:**

- 4351 - Determined physiological indicators of attention.
  - Created database structures allowing for multimedia fusion and the identification and indexing of the data uncertainties in data.
  - Redesigned FOX, a Course of Action (COA) analysis tool, based on user evaluations and identified new ways of problem solving resulting from human-computer interaction (HCI) with FOX.
  - Used SOAR, a micro-model, to develop a working cognitive model for cognitive task analysis of an S-3 (Maneuver).
  - Began integration of CECOM "CADET", Planning and Application tool, with Fed Lab "FOX" Course of Action analysis tool.
  - Initiated testing of a multi-modal (speech, gaze, gesture - I/O) (Common Object Oriented Broker Architecture) CORBA-based, non-platform specific architecture for touchless interaction with a computer.

Total 4351

**FY 1999 Planned Program:**

- 4299 - Perform scaling studies of spatial reasoning in a large, multi-dimensional battlefield database.
  - Link FOX COA tool to Decision-Analytic Wargaming tool, OWL, to analyze the efficacy of COAs, and demonstrate combined system [linked to CECOM Battlefield Visualization (BV) STO].
  - Integrate and evaluate multi-modal inputs (speech, gaze, gesture and tactile) into battlefield visualization and simulation environments.
  - Display information from widely distributed Microsensor network on commander's workstation.
  - Demonstrate cross-consortium (Displays, Sensors and Telecommunications) research products using the architecture developed in the Integration Support Laboratory (ISL).

Project BH56

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<p><b>FY 1999 Planned Program: (continued)</b></p> <ul style="list-style-type: none"> <li>- Establish audio icons for joint modality displays.</li> <li>- Complete integration of FOX &amp; OWL with CADET.</li> <li>- Plan for and begin implementation of Cognitive Engineering Applications research in the collaborative planning and maneuvering area.</li> </ul> <table border="0"> <tr> <td style="vertical-align: top;">•</td> <td style="vertical-align: top; text-align: right;">117</td> <td style="vertical-align: top;">- Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs</td> </tr> <tr> <td style="vertical-align: top;">Total</td> <td style="vertical-align: top; text-align: right;">4416</td> <td></td> </tr> </table> <p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 5896 - Transition refined integrated course of action development and analysis tools for use in collaborative technology STO and ATDs.</li> <li>- Implementation of a registration system and technique for overlaying 3D information onto video or see-through HMD.</li> <li>- Publish guidelines, methods and procedures for development of more effective visual-auditory displays and guidance on use of eyetracking in interacting with displays.</li> <li>- Set of Beta algorithms for vision-based gesture analysis, for speech/gesture integration, and for bimodal speech recognition as well as selected foreign language translation (DRAGON).</li> <li>- Transition Automation Speech Recognition (ASR) server to collaborative technologies STO and ATDs.</li> <li>- Provide initial cognitive Engineering Applications model(s) to collaborative technology STO, CECOM and Battle Labs (support output of Cognitive Engineering STO).</li> </ul> <table border="0"> <tr> <td style="vertical-align: top;">Total</td> <td style="vertical-align: top; text-align: right;">5896</td> <td></td> </tr> </table> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 5992 - Finalize and finish refinement of ISL architecture and transition package to CECOM and Battle Labs.</li> <li>- Develop algorithms using wavelets and fractals for embedded coding of image/video.</li> <li>- Incorporate talking and gesturing avatars into collaborative planning and execution scenarios.</li> <li>- Extend the FOX-RAVEN-CADET paradigm to include collaborative planning within the intelligence arena.</li> <li>- Using Army Soar-MODSAF architecture: provide a commander/staff model capable of conducting cognitive engineering of Army command and control interfaces; create model-opposing force commanders to direct other Soar-controlled unit entities.</li> <li>- Investigate technologies to enable commanders to tailor C2 systems to support their individual cognitive processes.</li> <li>- Research intelligent systems that provide an enabled understanding of information needs for situation and tasks.</li> </ul> <table border="0"> <tr> <td style="vertical-align: top;">Total</td> <td style="vertical-align: top; text-align: right;">5992</td> <td></td> </tr> </table>			•	117	- Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs	Total	4416		Total	5896		Total	5992	
•	117	- Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs												
Total	4416													
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<div style="display: flex; justify-content: space-between;"> <span>Project BH56</span> <span>Page 10 of 20 Pages</span> <span>Exhibit R-2A (PE 0601104A)</span> </div>														

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COST (In Thousands)	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
BH59 University Centers of Excellence	3964	4247	6262	6568	7147	5284	5581	5914	Continuing	Continuing

**A. Mission Description and Justification** Army Centers of Excellence are active in the fields of rotary wing technology, fuel cell technology, the foundations of image science, and science, mathematics, and engineering (SME) training. The Army's Centers have significant collaborative participation by Historically Black Colleges and Universities/Minority Institutions (HBCU/MI) and all future Army Centers will be formed in partnerships with an HBCU. In addition, industry will be encouraged to "buy into" future Army Centers of Excellence to leverage and synergize the investment in these collaborative efforts.

**FY 1998 Accomplishments:**

- 1612 - Conducted interdisciplinary investigations at Penn State University, the University of Maryland and Georgia Institute of Technology on topics of specific relevance to rotorcraft science and technology base in conjunction with the National Rotorcraft Technology Center.
- 2352 - Synthesized inorganic-polymer nanoscale composites for new cathodes for improved batteries at the Illinois Institute of Technology.  
 - Applied computer aided design to the modeling of forward looking infrared and laser radars at the Washington University to optimize the fusion of sensor information for automatic target recognition.  
 - Increased the number of underrepresented minority students in the fields of science, mathematics and engineering who advanced from Contra Costa College to four year colleges and universities including Brown, UCLA, UC-Berkeley, and Arizona State universities.

Total 3964

**FY 1999 Planned Program:**

- 1802 - Conduct interdisciplinary investigations at Penn State University, the University of Maryland and Georgia Institute of Technology on topics of specific relevance to rotorcraft science and technology base in conjunction with the National Rotorcraft Technology Center.
- 2333 - Conclude research at the Illinois Institute of Technology center on advanced fuel cell and advanced battery research and transfer the results to advanced research and advanced technology development.  
 - Develop algorithm independent, fundamental bounds on determining the position and orientation of targets by any sensor at the Johns Hopkins University's Center on image analysis and metrics.  
 - Support science, mathematics and engineering (SME) education at Contra Costa College to strengthen academic programs in SME and attract underrepresented minority students to carriers in these fields.
- 112 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs

Total 4247

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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>		DATE <b>February 1999</b>
BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601104A University and Industry Research Centers</b>	PROJECT <b>BH59</b>
<p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 2000 - Conduct interdisciplinary investigations at Penn State University, the University of Maryland and Georgia Institute of Technology on topics of specific relevance to rotorcraft science and technology base in conjunction with the National Rotorcraft Technology Center.</li> <li>• 2246 - Explore new algorithms and model concepts to develop a set of scientific metrics which quantify image content and complexity for automatic target recognition at the Johns Hopkins University center. <ul style="list-style-type: none"> <li>- Support science, mathematics and engineering (SME) education at Contra Costa College to strengthen academic programs in SME and attract underrepresented minority students to carriers in these fields.</li> <li>- Conduct multidisciplinary research in landmine detection and identification which will include efforts involving sensors, sensor and data fusion, discrimination techniques, and response stimulation.</li> </ul> </li> <li>• 2016 - Link entertainment industry and defense through the development of a center to research networked, realistic simulation tools focused on incorporating entertainment industry methods and data into combat training devices. <ul style="list-style-type: none"> <li>- Explore emerging entertainment technologies that may be applicable to meet future Army training needs.</li> <li>- Research applicability of entertainment database tools and methods for use in Army modeling and simulation.</li> </ul> </li> </ul> <p>Total            6262</p> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 2000 - Conduct interdisciplinary investigations at Penn State University, the University of Maryland and Georgia Institute of Technology on topics of specific relevance to rotorcraft science and technology base in conjunction with the National Rotorcraft Technology Center.</li> <li>• 2270 - Develop computer models of targets and synthetic image generation to guide theoretical work and verify existing image recognition theories at the Johns Hopkins University center. <ul style="list-style-type: none"> <li>- Support science, mathematics and engineering (SME) education at Contra Costa College to strengthen academic programs in SME and attract underrepresented minority students to carriers in these fields.</li> <li>- Conduct multidisciplinary research in landmine detection and identification which will include efforts involving sensors, sensor and data fusion, discrimination techniques, and response stimulation.</li> </ul> </li> <li>• 2298 - Support research center on networked, realistic simulation tools focused on incorporating entertainment industry methods and data into combat training devices. <ul style="list-style-type: none"> <li>- Explore emerging entertainment technologies that may be applicable to meet future Army training needs.</li> <li>- Research applicability of entertainment database tools and methods for use in Army modeling and simulation.</li> </ul> </li> </ul> <p>Total            6568</p>		
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BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601104A University and Industry Research Centers</b>				PROJECT <b>BH62</b>		
COST (In Thousands)	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
BH62 Electromechanics and Hypervelocity Physics	9041	8669	6905	7006	7128	6404	5701	6102	Continuing	Continuing
<p><b><u>Mission Description and Justification:</u></b> Electromechanics and hypervelocity physics support critical Army research relating to electromechanical components (electromagnetic launchers and power supplies) for applications to electromagnetic (EM) and electrothermal-chemical (ETC) guns. Additionally, this project provides for research, testing and computer modeling of advanced hypervelocity projectiles. This project funds a University Affiliated Research Center, the Institute for Advanced Technology (IAT), at the University of Texas. In keeping with the Army Electric Armaments Program strategy, highest emphasis has been placed on advancing the state-of-the-art in pulsed power and on establishing the utility of hypervelocity projectiles. The sum of these focused efforts serves as a catalyst for technological innovation and provides crucial support to the Army technology base for advanced weapon systems development with potential applications for anti-armor, artillery and air defense.</p> <p><b>FY 1998 Accomplishments:</b></p> <ul style="list-style-type: none"> <li>• 9041 - Demonstrated gouge resistant rail configuration.</li> <li style="padding-left: 20px;">- Designed and tested low parasitic mass launch packages.</li> <li style="padding-left: 20px;">- Conducted laboratory experiments on hypervelocity novel penetrators versus advanced armors.</li> <li style="padding-left: 20px;">- Demonstrated hypervelocity novel penetrator capable of meeting exit criteria.</li> <li style="padding-left: 20px;">- Provided electrophysical education support to the Army.</li> <li style="padding-left: 20px;">- Performed critical studies to support electromagnetic (EM) and electrothermal-chemical (ETC) pulsed power needs.</li> </ul> <p>Total 9041</p> <p><b>FY 1999 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 8439 - Demonstrate efficient hypervelocity gun launch of lethal launch packages with sufficient gun rail life and projectile accuracy to compete with conventional gun technology.</li> <li style="padding-left: 20px;">- Show superior defeat of advanced armors with hypervelocity penetrators.</li> <li style="padding-left: 20px;">- Establish the system utility of the EM gun concept.</li> <li style="padding-left: 20px;">- Support the compulsator exploitation efforts and explore alternative technologies.</li> <li>• 230 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs</li> </ul> <p>Total 8669</p>										
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BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601104A University and Industry Research Centers</b>	PROJECT <b>BH62</b>
<p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li>6905 - Prove the robust defeat capabilities of hypervelocity penetrators.</li> <li>- Examine launcher and launch package technologies for future field applications.</li> <li>- Examine integration of EM and ETC into future fighting vehicles.</li> <li>- Support alternative EM pulsed power applications.</li> <li>- Begin study of advanced ETC pulsed power.</li> <li>- Provide high current, fast transient switching for EM pulsed power.</li> <li>- Examine electric power generation, storage and distribution for mobility.</li> </ul> <p>Total 6905</p> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>7006 - Exploit robust novel hypervelocity penetrator.</li> <li>- Test material and structural components of launchers and launch packages for future field applications.</li> <li>- Test alternate EM pulsed power options.</li> <li>- Fabricate advanced ETC pulsed power.</li> <li>- Provide advanced switch technology for mobility.</li> <li>- Evolve thermal management technology for EM pulsed power, switching, and railgun needs.</li> </ul> <p>Total 7006</p>		
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BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601104A University and Industry Research Centers</b>				PROJECT <b>BH64</b>		
COST <i>(In Thousands)</i>	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
BH64 Materials Center of Excellence	1736	2221	2434	2472	2511	2560	2761	2925	Continuing	Continuing

**Mission Description and Justification:** This project promotes long-term collaboration between the Army Research Laboratory (ARL), Aberdeen Proving Ground, MD and University/Industry Research Centers for the purpose of conducting world class research and exploiting fundamental breakthroughs in materials science relevant to Army needs. Basic research in materials science and engineering is focused on the Army's armor, armament, soldier protective mission, and related Defense Science Research Objectives. The project currently emphasizes advanced materials characterization, composite materials and dendritic polymers research for lightweight, structural armor and armaments; integrated and multifunctional composites; chemical biological barrier materials and other critical applications. Current collaborative research agreements are with the University of Delaware, Johns Hopkins University, Baltimore, MD, and Michigan Molecular Institute. This work is closely coordinated with the ARL in-house materials research project funded through PE 0601102A, Project AH42.

**FY 1998 Accomplishments:**

- 1736 - Characterized graded metal matrix composites using near-field ultrasonic probe technology.
- Fabricated, characterized, and modeled multi-layer Nb/Si, Ni/Si, and CuO<sub>2</sub> foils designed for self-propagating, exothermic reaction joining of metals and ceramics.
- Characterized the role of inclusions on hydrogen transport in multi-layer metallic films.
- Established a process for multi-resin co-injection of integral composite armor material.
- Measured and analyzed dispersion and dissipation phenomena of shock wave propagation in woven fabric composites.
- Synthesized and characterized the structure of novel hyperbranched and dendrigraft polymers and encapsulated inorganic nanocomposites.

Total 1736

**FY 1999 Planned Program:**

- 2162 - Characterize SiC surfaces and thermal cycling effects on electrical, structural and metallurgical properties of SiC contacts and interfaces.
- Model and demonstrate novel, low-cost co-injection processing of stitched, integral composite armor materials.
- Develop micromechanical models that incorporate polymer-fiber interphase phenomena and accurately predict processing and moisture effects on residual stress and other critical composite material properties.
- Develop new model and improved Ion Beam Assisted Deposition processing technology that involves photon stimulated dissociation of absorbed hydrogen to explain and control the formation of diamond-like coatings on surfaces of advanced materials.
- Develop novel dendritic and hyperbranched polymer-fiber surface treatments and significantly enhance the environmental durability and shear/impact resistance of composite materials.

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BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601104A University and Industry Research Centers</b>	PROJECT <b>BH64</b>
<p><b>FY 1999 Planned Program: (continued)</b></p> <ul style="list-style-type: none"> <li>• 59 - Design and demonstrate dendritic polymer substrate and bioconjugate materials for use in biotoxin detection and immobilization.</li> <li>• 59 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs</li> </ul> <p>Total 2221</p> <p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 2434 - Design and evaluate computational models to represent progressive damage in fiber-reinforced, polymer composites under shock loading.</li> <li>- Develop and demonstrate novel experimental techniques to measure nanoscopic mechanical properties and understand high-strain rate behavior in sub-micron region next to fiber surfaces and at the interface between dissimilar materials.</li> <li>- Develop and demonstrate in-situ ultrasonic velocity technique for process monitoring of transparent armor ceramic (ALON) transient liquid phase sintering.</li> <li>- Develop and implement procedures for low-cost, large-scale synthesis of novel thermally stable and adaptable, hyperbranched dendrimers for possible use in protective clothing, membranes and coatings.</li> <li>- Design and synthesize adaptable, hyperbranched dendrimers.</li> <li>- Develop nanocomposite materials for environmentally friendly, chemical/ biological agent decontamination.</li> </ul> <p>Total 2434</p> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 2472 - Extend basic theory, processing technology, and testing methodology for tailoring and characterizing fiber surfaces, fiber-matrix interphase, matrix composition, and 3-D architecture of fiber-reinforced composite materials.</li> <li>- Establish guiding principles for data documentation, testing and design of multi-functional, integrated composite materials.</li> <li>- Develop transport models and extend basic knowledge to describe and understand penetrant-penetrant and penetrant-polymer interactions in multiphase polymer systems and for selective/controlled transport of penetrants in tailored "smart" polymer membranes and coatings.</li> <li>- Establish underpinning theory and processing technology for rapid repair and joining of dissimilar metals/ceramics by self-propagating reactions in multi-layer foils.</li> </ul> <p>Total 2472</p>		
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BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601104A University and Industry Research Centers</b>					PROJECT <b>BH65</b>	
COST <i>(In Thousands)</i>	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
BH65 Microelectronics Center of Excellence	1853	2314	1973	2005	2037	2667	2858	3021	Continuing	Continuing

**Mission Description and Justification:** The Microelectronics Research Collaborative Program (MCRP) will establish a long term collaboration between ARL Physical Sciences Directorate and universities to ensure a seamless, synergistic cooperative work environment to provide the Army the key technologies and analytical support necessary to assure supremacy in future land warfare. The goals of this effort are to conduct innovative research and exploit new concepts in solid-state physics, electronics engineering and chemical/electrochemical engineering, and provide mutual exchange of public and private sector researchers working at each other's institutions. The technical areas being addressed under this project are: nanoelectronics/optoelectronics; electrochemistry/energy science; biological/chemical detection; high frequency and quasi-optical electronics; piezoelectronics; microelectromechanics.

**FY 1998 Accomplishments:**

- 1853 - Threshold current in vertical cavity surface emitting lasers (VCSECs) reduced to below 1 milliamp using oxidation fabrication techniques.
- Incorporated lanthanum strontium cobalt oxide (LSCO) conducting perovskite oxide into an uncooled infrared (IR) sensor structure.
- Tapered optical fiber flucrosensor with one square foot footprint developed for the detection of chemical and biological agents. Sensitivity measured as low as 25 pico-roles per milliliter when detecting helicobacter pylori.

Total 1853

**FY 1999 Planned Program:**

- 2253 - Perform research in ultra-small/nano-scale electronic/photonic device structures addressing modeling, materials, nanofabrication, characterization, and measurement of performance for high-speed signal processing.
- Investigate heterostructures, materials, optical sources, detectors, waveguides, phase shifters, and optoelectronic integrated circuits for optical signal processing and optoelectronic component technology.
- Study device physics of optoelectronic (OE) devices as well as design, fabrication, radio frequency (RF)/optics integration and optical interconnects. Investigate the device physics, fabrication methods, and characterization of electronic and OE devices operating in the millimeter-wave, terahertz, and light-wave domains for radar, communications-on-the-move, and target acquisition.
- Explore new materials, components and fabrication techniques to improve performance, increase safety, and reduce life-cycle costs of high density primary and rechargeable batteries and fuel cells for man-portable applications.
- Conduct fundamental research into new classes of chemical/biological microminiature sensors interfaced with micro-optoelectronic circuitry, multi-toxin sensor arrays, and ultra-sensitive detection materials for miniature, low-cost detectors.
- 61 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs

Total 2314

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PROJECT <b>BH65</b>		
<b>FY 2000 Planned Program:</b> <ul style="list-style-type: none"> <li>           1973 - Research novel electronic and optoelectronic materials and devices for multifunctional, miniature sensors.         </li> <li>           1973 - Investigate the potential for new sensors and sensor processing based on the development of new electronic and optoelectronic devices.         </li> </ul>		
Total	1973	
<b>FY 2001 Planned Program:</b> <ul style="list-style-type: none"> <li>           2005 - Research novel electronic and optoelectronic materials and devices for multifunctional, miniature sensors         </li> <li>           2005 - Investigate the potential for new sensors and sensor processing based on the development of new electronic and optoelectronic devices.         </li> </ul>		
Total	2005	
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BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601104A University and Industry Research Centers</b>				PROJECT <b>BH73</b>		
COST (In Thousands)	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
BH73 National Automotive Center of Excellence	2707	2719	2877	2936	2976	3168	3670	3740	Continuing	Continuing
<p><b><u>Mission Description and Justification:</u></b> The Center of Excellence for Automotive Research, established in 1994, is a key element of the basic research module of the National Automotive Center (NAC), located at the U.S. Army Tank-Automotive Research, Development, and Engineering Center (TARDEC). The Center of Excellence for Automotive Research is an innovative university/industry/government consortium leveraging commercial dual use technology for the Army through on-going and new programs in automotive research, allowing significant cost savings while maximizing technological productivity. The selected university partners include: University of Michigan, University of Iowa, University of Wisconsin, Wayne State University, University of Alaska, University of Tennessee, and Clemson University, while key industry partners include the major U.S. automotive manufacturers and suppliers.</p> <p><b>FY 1998 Accomplishments:</b></p> <ul style="list-style-type: none"> <li>• 2707 - Completed initial overall vehicle simulation model.</li> <li style="padding-left: 20px;">- Completed dual-need virtual prototyping infrastructure.</li> <li style="padding-left: 20px;">- Extended experimental validation of models using state-of-the-art transient prototypes.</li> </ul> <p>Total 2707</p> <p><b>FY 1999 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 2650 - Complete optimization of dual-need overall simulation network.</li> <li style="padding-left: 20px;">- Complete experimental validation of fully functional system model using advanced hardware prototypes.</li> <li style="padding-left: 20px;">- Finalize detailed mechanism of effective government, industry and academia partnering and provide recommendations for future relevant tasks.</li> <li>• 69 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs</li> </ul> <p>Total 2719</p> <p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 2877 - Initiate derivation of next generation of high fidelity military vehicle simulation models.</li> <li style="padding-left: 20px;">- Assess accuracy of new simulation capability using enhanced, unique experimental procedures.</li> </ul> <p>Total 2877</p>										
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BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601104A University and Industry Research Centers</b>	PROJECT <b>BH73</b>
<p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 2936 - Incorporate new generation building blocks for enhanced military vehicle simulation models.</li> <li>- Assess new simulation model accuracy over a wide range of military vehicles and conditions.</li> </ul> <p>Total 2936</p>		
<p>Project BH73</p> <p align="center"><i>Page 20 of 20 Pages</i></p> <p align="right">Exhibit R-2A (PE 0601104A)</p>		